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Influence of underwater barriers on the distribution of tsunami waves

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Abstract

© 2014. American Geophysical Union. All Rights Reserved. Solitary wave propagation over underwater shelves and bumps is examined using straightforward analytical methods. Explicit solutions for wave propagation are obtained. Using the nonlinear shallow-water equations, it was found that propagation of small amplitude long waves can be well described by a linear approximation. The effects of topographical variety and proportion of underwater barriers (steps, bumps, multiple bumps) on the incident wave are demonstrated using linear wave theory. At a step, the incident wave is shown to be more strongly reflected for increased barrier size. The incident wave also transmits an amplified wave with smaller wavelength onto the obstacle. After propagating off of a bump, the wave experiences an amplitude decay. The decay rate is shown to be exponential with a variable number of bumps. Accounting for the presence of the small parameter, which represents the wave amplitude/water depth ratio, the nonlinear shallow-water equations were solved by the method of asymptotic expansions. Using the method of renormalization, a uniformly valid solution was obtained accounting for nonlinear effects in the vicinity of the sharp depth change. Far-field comparisons of the constructed solutions with the associated Riemann waves show good accuracy of the obtained solutions. Over an infinitely long shelf, the amplified transmitted wave breaks.

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Keywords

bump, shallow water, shelf, tsunami, wave